SEE Test report V1.0
Heavy ion SEE test of RH1013 from Linear Technology

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Test Date(s): November 16-19, 2006 Report Date: May 24, 2007

I. Introduction

This study was undertaken to determine the single event destructive and transient susceptibility of the RH1013MW dual precision operational amplifier. The device was monitored for transient interruptions in the output signal and for destructive events induced by exposing it to a heavy ion beam at the Texas A&M University Cyclotron Single Event Effects Test Facility. This test was performed in the frame of LRO project.

II. Devices Tested

The sample size of the testing is three devices taken from LRO flight lot. Two devices were exposed and one served as a control sample. The device is manufactured by Linear Technology. Test samples package marking is as follows:

LT Δ

RH1013M W

0343A

The device technology is bipolar. The device is packaged in a 10-lid ceramic flat package. The device was prepped for test by delidding.

III. Test Facility

Facility: Texas A&M University Cyclotron Single Event Effects Test Facility, 15 MeV/amu tune)

Flux: 1×10^3 to 5×10^4 particles/cm^2/s.

Fluence: For destructive events, all tests were run to 1×10^7 p/cm^2 or until destructive events occurred

For non destructive events, all tests were run to 1×10^6 p/cm^2 or until a sufficient (>100) number of transient events occurred.

The ions and LET values planned for these tests are shown in Table 1.

Table 1: Ion an LET values for 0 degree incidence

Ion	LET at DUT ($MeV \cdot cm^2/mg$)	Range at DUT (μm)
Ar	8.7	174
CU	20.7	118
Kr	29.3	116
Xe	53.9	102

IV. Test Conditions and Error Modes

Test Temperature: Room Temperature

Bias conditions: Vcc=+/- 15V
Vin1 = +5V, Vin2 = -5V
DUT was biased in voltage follower configuration as shown in Figure 1.

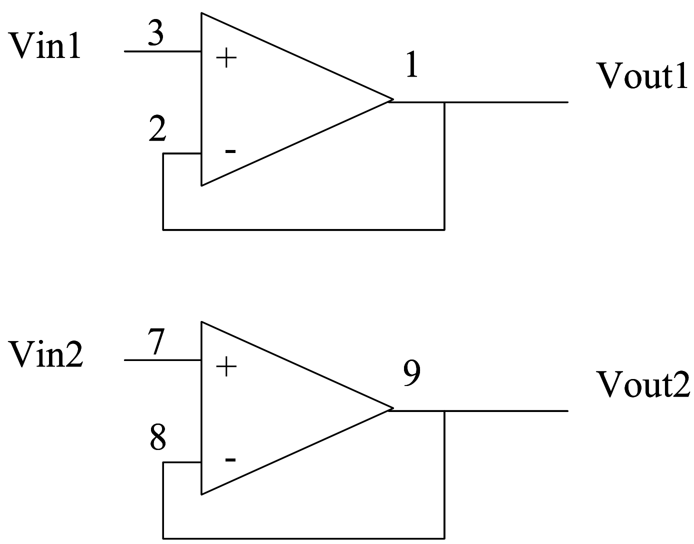

Figure 1: Bias conditions

PARAMETERS OF INTEREST: Power supply currents, output voltage

SEE Conditions: SEL, SEGR, SET

V. Test Methods

Test circuit, as shown in Figure 2, for the operational amplifier contains a power supplies to provide +/-15V power supplies and input voltages, and a digital scope for capturing any output anomalies. Once the output is present, the digital scope is set to trigger on output voltages that are above or below a predetermined threshold (set to 200 mV).

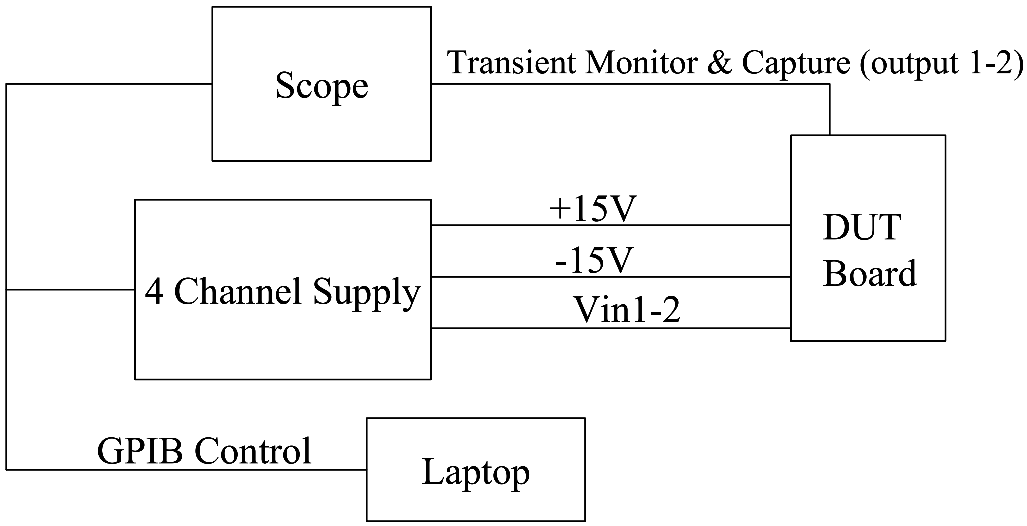

Figure 2. Overall Block Diagram for the testing of the RH1013.

VI. Test Results

Detailed test results are shown in Table 1. No destructive event was observed at the highest tested LET of 76 MeVcm2/mg up to a fluence of 1E7 #/cm^2 on two parts. SET cross-section curves are shown in Figure 3. Both in Table 1 and Figure 3, cross-section is the total cross-section for the two tested operational amplifiers in the DUT. For one operational amplifier, SET cross section is about half the total measured cross-section. Number of transients was about the same on the two operational amplifiers. SET characteristics are also similar even though bias conditions are different.

Table 2: Test results

Run #	**DUT** #	**Ion**	**LET** (MeVcm²/mg)	**Angle** (º)	**Eff. LET** (MeVcm²/mg)	**Eff. Fluence** (#/cm²)	**Acq** #	**Dwnld** #	**SET X section** (cm²/2 op amp)
002	1	Xe	53.90	45.00	76.23	3.39E+05	124	108	3.66E-04
003	1	Xe	53.90	0.00	53.90	3.93E+05	147	127	3.75E-04
004	2	Xe	53.90	0.00	53.90	2.95E+05	116	102	3.93E-04
005	2	Xe	53.90	45.00	76.23	3.52E+05	125	111	3.55E-04
006	2	Xe	53.90	45.00	76.23	1.00E+07	3033	1220	3.03E-04
007	2	Kr	29.30	45.00	41.44	1.18E+06	120	109	1.02E-04
008	2	Kr	29.30	0.00	29.30	1.44E+06	133	107	9.25E-05
009	1	Kr	29.30	0.00	29.30	1.44E+06	129	107	8.94E-05
010	1	Kr	29.30	45.00	41.44	9.66E+05	127	106	1.32E-04
011	1	Cu	20.70	45.00	29.27	1.75E+06	174	132	9.92E-05
012	1	Cu	20.70	0.00	20.70	2.79E+06	262	166	9.39E-05
013	2	Cu	20.70	0.00	20.70	1.90E+06	146	106	7.70E-05
014	2	Cu	20.70	45.00	29.27	1.60E+06	134	103	8.40E-05
015	2	Ar	8.70	45.00	12.30	1.00E+07	14	14	1.40E-06
016	2	Ar	8.70	0.00	8.70	9.96E+06	1	1	1.00E-07
017	1	Ar	8.70	0.00	8.70	9.99E+06	0	0	1.00E-07
018	1	Ar	8.70	0.00	8.70	9.99E+06	1	1	1.00E-07
019	1	Ar	8.70	45.00	12.30	1.00E+07	23	23	2.30E-06

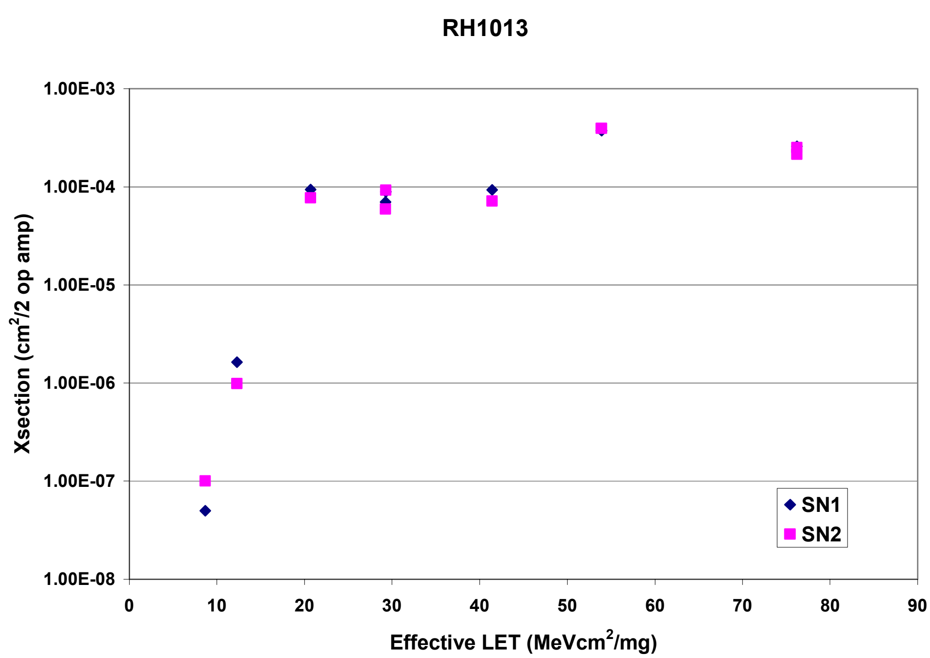

Figure 3: SET cross-section

Figure 3 shows SET amplitude versus SET width plot for each SET observed during irradiation run number 2. Plots are similar for all runs.

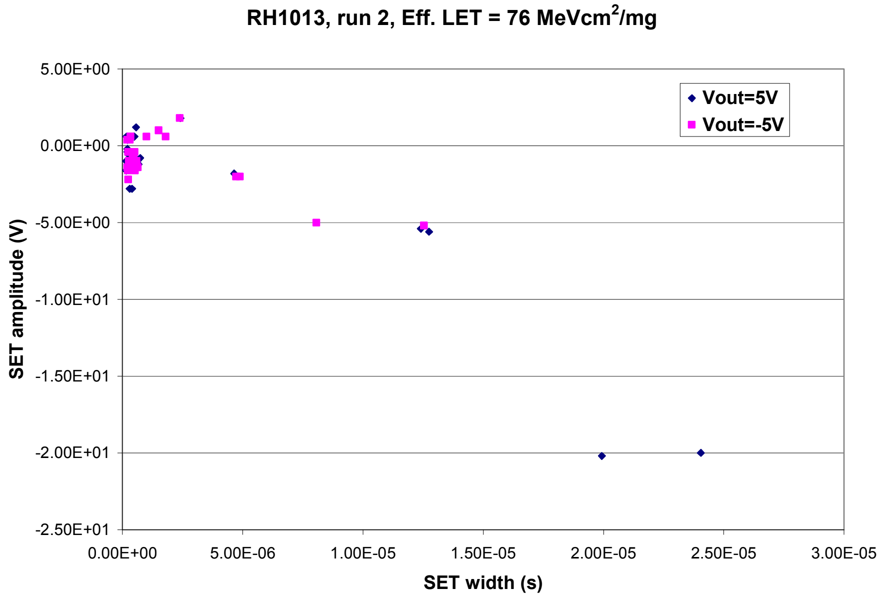

Figure 3: SET amplitude versus width for irradiation run 2

We can distinguish 3 kinds of transients:

- small positive going SETs
- medium amplitude bipolar SETs
- large negative going SET

Figures 4 and 5 show typical positive going SET for positive and negative output voltage respectively.

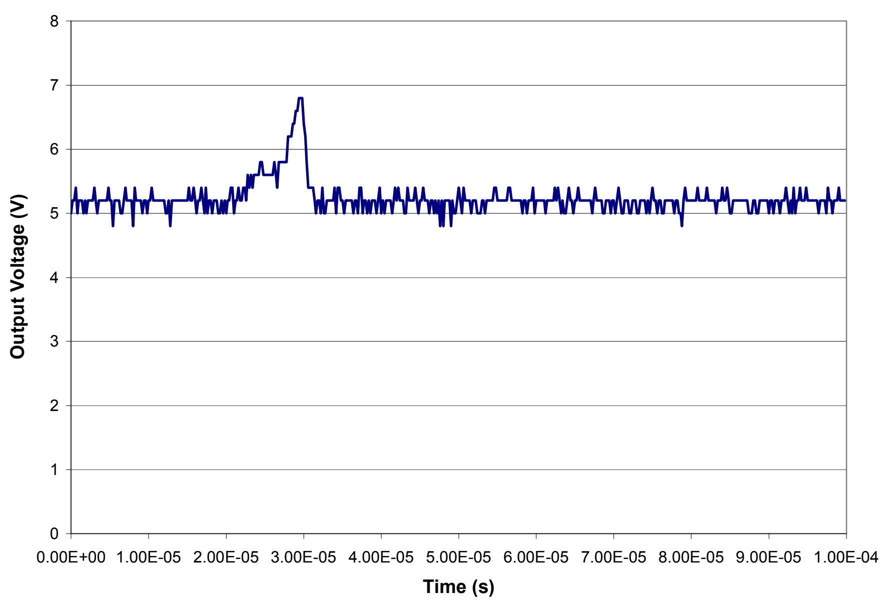

Figure 4: typical positive going SET, Vout=+5V

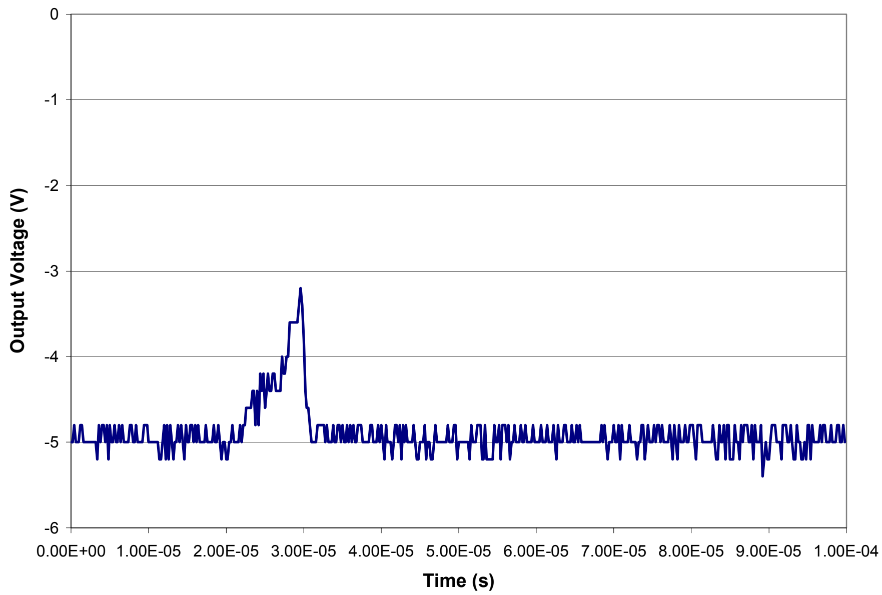

Figure 5: Typical positive going SET, Vout=-5V

Figure 6 shows a typical bipolar SET.

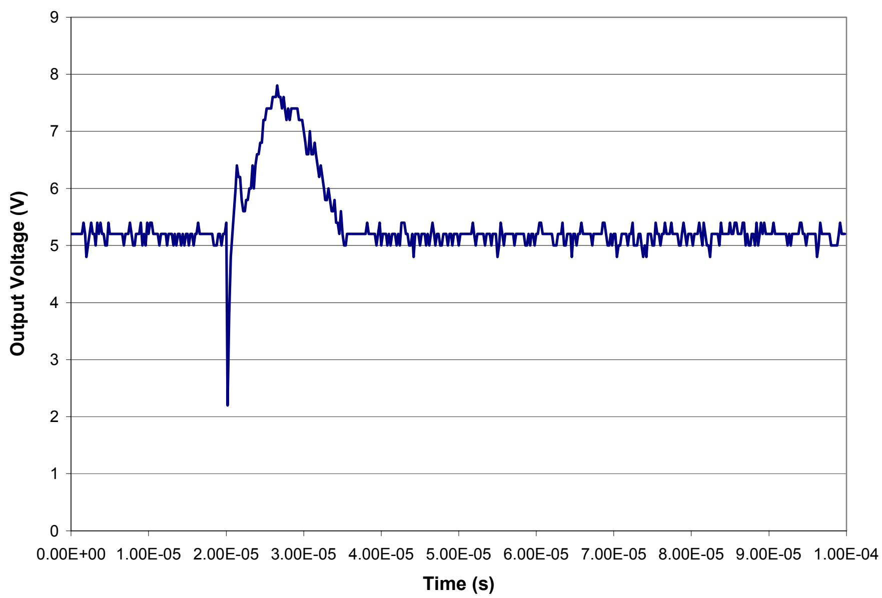

Figure 6: Typical bipolar transient

Figures 7 and 8 show the worst case SET for positive and negative output voltage respectively.

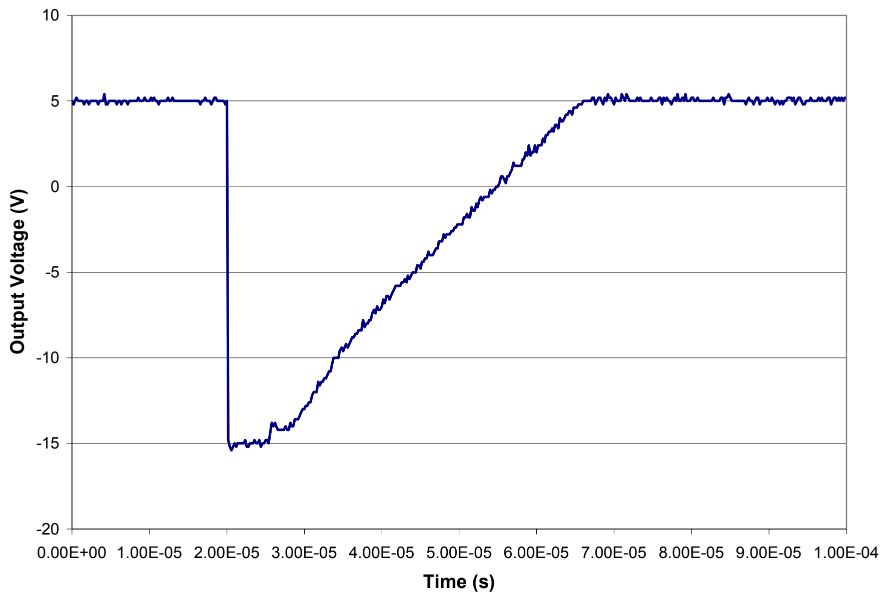

Figure 7: worst-case negative going SET, Vout=+5V

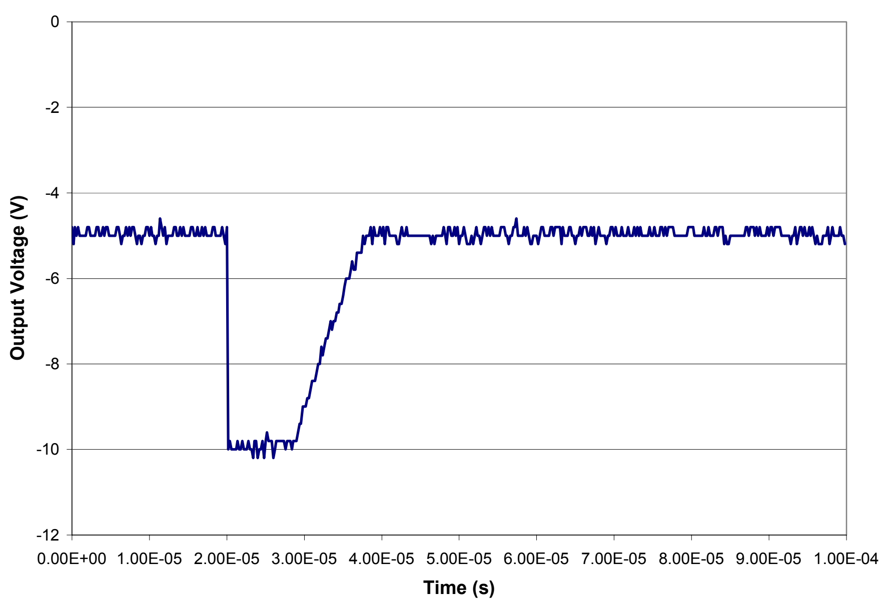

Figure 8: worst-case negative SET, Vout=-5V

VII. Comments

The RH1013 is not sensitive to destructive events and is moderately sensitive to SET.